

**Reducing Loneliness amongst Older Adults via Embodied Conversational Agents:**

*An exploratory PACO Pilot Study*

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Wageningen University & Research

November, 2020

## Abstract

High prevalence of loneliness amongst older adults is a problem in our current society. As loneliness has multiple negative (health) consequences, reducing these feelings of loneliness amongst older adults is necessary. Embodied Conversational Agents (ECAs) have the potential to reduce loneliness for a large number of people. Research on use and effect of ECAs and how ECAs could reduce loneliness is scarce. Therefore, the aim of this research is to study if and how ECAs may reduce feelings of loneliness amongst older adults. A conceptual model of ECAs reducing loneliness was developed. It was expected that the relationship a user develops with the ECA and use of the ECA influence loneliness. Use of the ECA also leads to exposure to the Behaviour Change Techniques (BCTs) action planning, social learning and social facilitation. These BCTs could influence autonomy and relatedness, which are expected to influence loneliness. An exploratory pilot study was conducted in which participants used the PACO (Designing Persuasive E-Health Agents for Coaching Older adults) application for 4 weeks. A mixed method approach was used by gathering log data, conducting a user experience questionnaire and conducting interviews. In total 10 participants, all females participated in this study, of which 2 dropped out early. User experience of the application was positive. Participants found interaction with the ECA to be an addition to the app, unnecessary or it was not consciously experienced. Modules in the application to reduce loneliness were not used extensively. Mainly because participants did not feel lonely in the first place. However, they do see the potential of ECAs for others who do feel lonely. The conceptual model of an ECA reducing loneliness cannot be validated with this study, since none of the older adults indicated a reduction in loneliness. However, almost all participants indicated they did not feel lonely before use of the application. Still, research shows that ECAs reducing loneliness for older adults has great potential.

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# 1. Introduction

“Loneliness is the discrepancy between an individual’s desired and achieved levels of social relationships”.

- Perlman & Peplau, 1981

## 1.1 Problem statement

This definition from 1981 by Perlman and Peplau seems ancient. However, the topic of loneliness and this definition are still relevant today, as prevalence of loneliness is still high. Prevalence of loneliness increases with age, with 5% of adults from 65 to 75 feeling lonely and 7% of adults above 75 feeling lonely (van Beuningen & de Witt, 2016). These numbers show that especially older adults are at risk of experiencing loneliness. This is due to their reduced social networks, decreased social and economic resources, decreased mobility, deaths of partners, relatives and/or friends and changes in family structure (Courtin & Knapp, 2017). The world is currently experiencing a pandemic caused by the coronavirus, which results in even higher levels of loneliness amongst older adults (Banerjee, 2020). Since older adults are a risk group for getting the virus, they are advised to isolate themselves and practice social distancing. This makes it harder to keep up social relationships (Banerjee, 2020). Loneliness is known to have negative consequences for both physical and mental health (Courtin & Knapp, 2017; Luanaigh & Lawlorz, 2008). Consequences include reduced well-being, mortality, depression, cognitive decline, higher blood pressure, worse sleep, and immune stress responses (Courtin & Knapp, 2017; Luanaigh & Lawlorz, 2008), which makes loneliness amongst older adults an even more relevant problem.

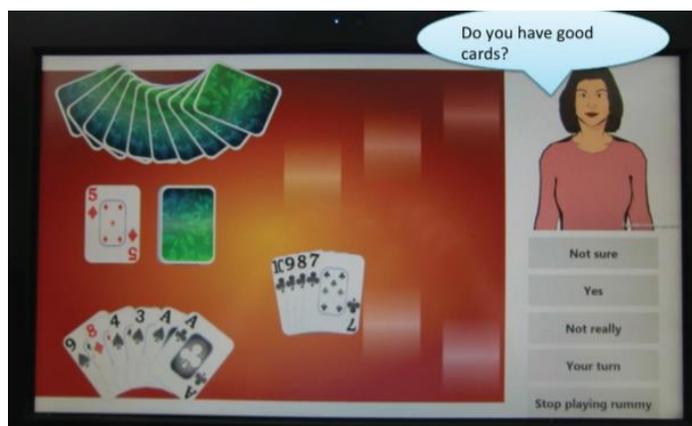
## 1.2 Reducing loneliness with eHealth

Over the years many interventions have been developed and implemented targeting loneliness amongst older adults (Landeiro et al., 2017). Types of interventions that have been

developed include social facilitation, psychological therapies, health and social care provision, animal interventions, befriending interventions, and leisure/skill development (Landeiro et al., 2017). Besides these, with the rise of the digital world, eHealth interventions are becoming more and more popular. These eHealth interventions are mostly done through the internet and/or web-based apps, like online chat platforms, social networking apps, e-mail, etc. (Chen & Schulz, 2016). According to Kreps and Neuhauser (2010) eHealth applications have great potential: “New eHealth applications hold tremendous promise to increase consumer and provider access to relevant health information, enhance the quality of care, reduce health care errors, increase collaboration, and encourage the adoption of healthy behaviours”. However, a recent systematic review concluded that evidence for reduction of loneliness amongst older adults with eHealth interventions is inconsistent and weak (Chipps, Jarvis & Ramlall, 2017). According to Bickmore and Giorgino (2006) this could be due to the fact that eHealth applications like these do not have the ability to have face-to-face interactions, which would provide users with tailored health education and induce healthy behaviour changes.

### **1.3 Embodied Conversational Agents**

An evolving technology and upcoming tool used in eHealth interventions which does have the ability to have face-to-face interactions, is an Embodied Conversational Agent (ECA) (Kramer, ter Stal, Mulder, De Vet & Van Velsen, 2020). Although there is not one clear definition of ECA, it is often described as something similar to “an interactive, animated computer character that simulates face-to-face counselling” (Klaassen et al., 2018). ECAs have emotion, personality, performatives, and conversational function. They are able to have natural conversations and functions in order to communicate with users (Cassell, Sullivan, Prevost & Churchill, 2000). An example of such an animated human-like ECA is shown in Figure 1. This ECA was developed by Bickmore et al. (2005) and is called Karen. The aim of this ECA was to support isolated adults in their homes (Sidner et al., 2018).



**Figure 1.** Example of the ECA Karen.

Research shows ECAs could be a promising tool to promote healthy lifestyles amongst older adults, since ECAs should be able to create, motivate, inspire and rapport (Kramer et al., 2020). Rapport means the ECA and the user will be able to communicate well and have a good relationship and understanding of each other (Cambridge Advanced Learner's Dictionary & Thesaurus, 2020). Only a few larger evaluations of ECAs have been done, especially ones that approach multiple aspects of well-being within older adults are rare (El Kamali, 2020). Studies that have been done show that ECAs are more effective than the standard eHealth intervention and can be as effective as 'the normal' human way of health provision and education. In combination with the ECA being available anywhere, anytime and the possibility of a large reach at relatively low costs, ECAs could have positive high impacts for public health (Bickmore & Giorgino, 2006).

#### **1.4 Aim and research questions**

The use and effect of ECAs has not been tested extensively, especially research focussing on ECAs to reduce loneliness is scarce (Laranjo et al., 2018). With ECAs having the potential to improve this for a large number of people, more research needs to be done. In addition, a current societal problem is the high prevalence of loneliness amongst older adults. Since loneliness has multiple negative (health) consequences, reducing these feelings of

loneliness amongst older adults is necessary. Therefore, the aim of this research is to study if and how ECAs may reduce feelings of loneliness amongst older adults. This will be done with an ECA developed by the PACO project, which will be explained in chapter 3. The following research question has been developed:

- How do ECAs influence loneliness amongst older adults?

In order to answer the main research question, sub research questions have been developed.

The first sub research question will be answered with log data:

- How do older adults use ECAs?

The second sub research question will be answered with the interviews and questionnaires:

- How do older adults experience using ECAs?

The following sub research questions will be answered with the interviews:

- To what extent do older adults experience and develop a relationship with an ECA and does this relationship influence loneliness?
- How do action planning, social learning and social facilitation influence feelings of autonomy and relatedness?
- How do feelings of autonomy and relatedness influence loneliness?

## 2. Theoretical framework

### 2.1 Conceptual model of an ECA reducing loneliness

This theoretical framework contains a conceptual model, consisting of several elements derived from various behavioural theories, that together help explain how the ECA might influence loneliness. This model is shown below in Figure 2. As can be seen in the figure, loneliness is the central part of the model. It is expected that the relationship a user develops with the ECA and use of the ECA directly influence levels of loneliness. Use of the ECA could influence loneliness via other mechanisms as well. Use of the ECA means exposure to Behaviour Change Techniques (BCTs) (Michie et al., 2013; Oinas-Kukkonen, 2009). These BCTs could influence autonomy and relatedness, which are part of the Self-Determination Theory (SDT) (Centre for Self-Determination Theory, 2020). Autonomy and relatedness are expected to then influence loneliness. These elements and mechanisms are explained in further detail in this chapter. Chapter 3.4 will explain how these concepts and mechanisms are applied in the PACO app.

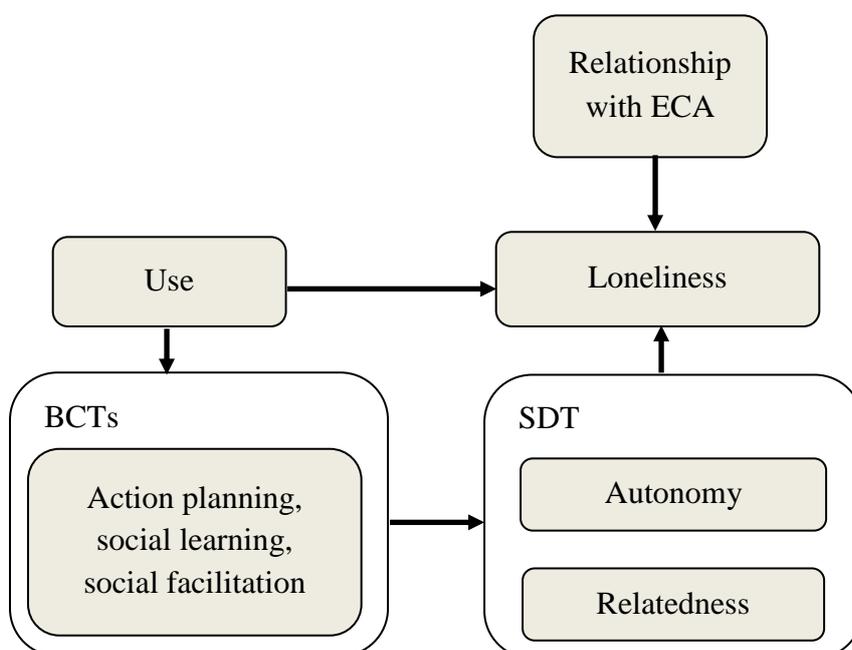


Figure 2. Model showing the effects of using an ECA.

## 2.2 Concept of loneliness

In Figure 2 it can be seen that all elements in the model eventually lead to a reduction in loneliness. However, the concept of loneliness has multiple different aspects, approaches and dimensions, since opinions on what loneliness entails differ. To understand the approach this research takes on the concept of loneliness, these differences will be explained in this chapter.

Loneliness does not have one explicit definition or one explicit approach. Three aspects of the concept of loneliness are agreed on for all the different definitions and approaches; (1) loneliness is a subjective experience; (2) loneliness is an adverse psychological state; (3) and the emergence of loneliness can be traced back to a form of lack of relationships (Peplau & Perlman, 1982).

Although these three aspects are agreed on, approaches to loneliness can still differ (Van Beuningen, Coumans & Moonen, 2018). Three different approaches are dominant in research on loneliness (Marangoni & Ickes, 1989). These approaches are the social needs approach, the behavioural/personality approach, and the cognitive processes approach. The social needs approach has brought forward psychological perspectives in which social needs are the underlying factors that make individuals experience loneliness. The behavioural/personality approach is based on the idea that lonely people have different characteristics and personalities than people who are not lonely. For example, lonely people are more likely to have behavioural problems, social skills deficits, etc. The cognitive processes approach focuses on the subjective experience of loneliness. This approach says people can feel lonely without physically being lonely (Marangoni & Ickes, 1989). This approach relates to the concepts emotional loneliness and social loneliness, which are differentiated within loneliness research. Emotional loneliness is feeling lonely and missing relationships, and social loneliness means being physically lonely and not having a social network (Grover, 2019;

O'Súilleabháin et al., 2019). Research has shown that emotional loneliness has a higher prevalence and is also more damaging for health (O'Súilleabháin et al., 2019).

Within this research the social needs approach is used. This approach is applied to the different modules in the PACO app. The PACO app tries to stimulate older adults to make social contacts and to satisfy their social needs. According to the social needs approach, satisfying social needs will make individuals experience less loneliness.

### **2.3 Relationship with and using the ECA**

As can be seen in Figure 2, loneliness could be directly influenced by the relationship with an ECA and by using an ECA. As described before, an ECA is “an interactive, animated computer character that simulates face-to-face counselling” (Klaassen et al., 2018). To clarify this definition, ECAs could also be described as “more or less autonomous and intelligent software entities with an embodiment used to communicate with the user” as stated by Ruttkay, Dormann and Noot (2004). The more general eHealth applications without ECAs have shown decrease in usage of the application after several weeks (Nijland, 2011). However, with ECAs being face-to-face communicators, the ECA is believed to be a promising tool to create an eHealth application that will make usage more permanent and stimulate engagement (ter Stal et al., 2020). Communicating face-to-face has proven to be one of the best manners to transfer health knowledge and information, since this allows for the assessment of the understanding of the communicated knowledge of the user. If necessary, the communicator could then react to this by repeating or explaining more to the user (Clark & Brennan, 1991). Besides that, trust, better communication, and higher satisfaction are gained from face-to-face communication (Bickmore, Pfeifer & Jack, 2009). With an ECAs ability of having emotions, having conversational functions, having a personality and performatives, natural conversations can be held with users (Cassell, Sullivan, Prevost & Churchill, 2000). By using an ECA, users come into contact with these functions of the ECA which should create rapport (Kramer et al., 2020).

Rapport means the ECA and the user will be able to communicate well and have a good relationship and understanding of each other (Cambridge Advanced Learner's Dictionary & Thesaurus, 2020). According to Gratch et al. (2006): “rapport is correlated with effective communication, greater liking and trust, and greater influence between participants.” Although concrete conclusions have not been drawn yet, it is believed that ECAs, containing these different functions, are the tool to stimulate motivation, to make users more engaged with using eHealth applications and to result in actual behaviour change (ter Stal et al., 2020). A recent ECA intervention by Sidner et al. (2018) showed the potential of an ECA reducing loneliness amongst older adults. This ECA could interact with users by telling them stories and playing online games together. Users indicated they felt like the ECA kept them company and provided them with social support and companionship (Sidner et al., 2018).

The PACO app aims to reduce loneliness amongst older adults by letting them form a relationship with the ECA and by using the ECA and the modules in the app. Participants are free to use the app as often as they would like. However, the ECA will initiate daily dialogues, which will show the ECAs characteristics. This could make the participant care more for the interaction and invest emotion in it, which will contribute to forming a relationship with the ECA (Cassell, Sullivan, Prevost & Churchill, 2000; Ring et al., 2015).

#### **2.4 Self-Determination Theory**

Besides the relationship with the ECA and using the ECA, levels of loneliness could also be influenced by the self-determination and motivation of individuals to perform a certain behaviour. Therefore, the SDT (Ryan & Deci, 2000) was used when developing the PACO app and incorporated in the modules of the PACO app. This is visualised in the conceptual model in Figure 2. SDT is an approach that suggests an individual's motivation to grow is because of intrinsic motivation and three universal psychological needs (Cherry, 2019; Ryan & Deci, 2000). These psychological needs are autonomy, competence, and relatedness. For this study,

only autonomy and relatedness are relevant, since competence cannot be applied to the modules in the PACO app trying to reduce loneliness. However, to clarify the mechanisms behind the SDT, competence will also be explained. Autonomy is an individual's need to feel in control of their behaviour, actions, and goals. Competence is about the skills individuals think they have, the skills needed to complete or do something successfully. Relatedness is about the need for sense of belonging, the need to connect with other individuals (Ryan & Deci, 2000). The fulfilment or satisfaction of these three needs leads to growth, integration, social and personal development, behaviours favourable to health, and improved mental health, which includes reduced feelings of loneliness (Ryan et al., 2008; Ryan & Deci, 2000).

In order to satisfy these three psychological needs, certain contextual and personal factors are optimizing. Such a contextual factor is the climate in which users are expected to change their behaviour. According to Ryan et al. (2008) an autonomy supportive climate is optimizing and means: "A treatment atmosphere that encourages individuals to engage in health-conducive behaviours for their own reasons, facilitates success in dealing with barriers to change, and conveys feelings of acceptance and respect." This is in contrast to a controlling climate in which people's behaviours are controlled and the pressure to perform is external. A personal factor is the goals that are being set. These should be personal and aim for growth, community involvement and meaningful relationships. In addition, motivation should be intrinsic, arising from the fundamental enjoyment of behaving a certain way (Ryan et al., 2008).

According to Chua and Koestner (2008), feeling autonomous means experiencing and performing a volitional or self-endorsed behaviour, which in this case are social behaviours influencing loneliness. Feeling pressured to perform a behaviour will have a counteracting effect and make people feel like they have less autonomy. Loneliness also depends on whether people feel autonomous about spending time alone or with others (Chua & Koestner, 2008). It

is expected that relatedness also affects loneliness, since this is about the feeling of connectedness to others.

## 2.5 Behaviour Change Techniques

In order to satisfy the needs of autonomy and relatedness in older adults, Behaviour Change Techniques (BCTs) were applied to the modules of the PACO app. The Liverpool John Moores University (2020) defines a BCT as: “a strategy that helps an individual change their behaviour to promote better health”. The conceptual model in Figure 2 shows that it is expected that three BCTs influence autonomy and relatedness; action planning, social learning, and social facilitation.

The first BCT, action planning, is from The Behaviour Change Technique Taxonomy (v1) developed by Michie et al. (2013). Action planning or setting goals has proven to influence autonomy. A positive influence is achieved when the set goal does not involve social pressures or expectations but is in line with an individual’s personal values and interests (Koestner, 2008). Within action planning, it is setting and achieving social goals, which will result in higher levels of relatedness. These social goals can be related to friendship and one’s social behaviour. Examples of such goals could be ‘meeting new people and interacting with them’ and ‘overcoming difficulty to be amongst other people’ (Stevens, 2001). The second BCT, social learning, is from the Persuasive Systems Design (PSD) Model developed by Oinas-Kukkonen (2009). Social learning is a BCT that falls under social support, which should motivate users by leveraging social influence. This entails that a user is more likely to perform a behaviour when they observe others perform the behaviour as well (Oinas-Kukkonen, 2009). It could contribute to both autonomy and relatedness. The last BCT, social facilitation, is also from the Persuasive Systems Design (PSD) Model (Oinas-Kukkonen, 2009). Social facilitation means that users are more likely to perform a behaviour when they learn that others are also performing the behaviour alongside them. It could create a feeling of relatedness since users

are performing certain behaviours together. Also, social facilitation could be useful for decreasing feelings of loneliness when used to forge new relationships. However, this is only true when digital technology is not used as an escape from the reality of social interaction, otherwise it results in increased feelings of loneliness. Having support during social internet use (the ECA), counteracts the increase and enhances existing relationships and forges new relationships (Nowland, Necka, & Cacioppo, 2018). This means individuals can ask for help if needed and have a support system around them which encourages use of the ECA.

### 3. The PACO project

#### 3.1 PACO: Persuasive ehealth Agents for Coaching Older adults

This research is part of a larger 3 year research project called PACO (Persuasive ehealth Agents for Coaching Older Adults). PACO is financed by ZonMw and consists of multiple organisations working together. These organisations are Wageningen University & Research (WUR), the National Foundation of the Elderly (NFE), Roessingh Research and Development (RRD) and Waag. Although these organisations are focussed on different disciplines and have different areas of expertise, they work together to integrate their knowledge into the project.

PACO focuses on improving eating behaviour and reducing loneliness amongst older adults by using persuasive ECAs. This research will solely focus on reducing loneliness, but in order to understand the setup of this research, the whole project needs to be explained. The project was established because literature about the use and effect of ECAs within the health sector is lacking. Also, overall design guidelines for persuasive ECAs in the health sector are missing. Therefore, the main goals of the PACO project are;

- Identifying determinants of the acceptance and success of ECAs for dietary change in older adults via an eHealth service;
- Explaining how interaction between ECAs and older adults evolves over time;
- Developing design guidelines for creating persuasive ECAs for eHealth services.

In order to design the most persuasive ECA, the project consists of conducting multiple studies. The project started with a systematic review about the development of ECAs for coaching people in a healthy lifestyle (Kramer et al., 2020) and a stakeholder analysis. Subsequently, five co-design sessions were held between the different partners and an older adults panel set up by the NFE. During these sessions a list of hindering factors to perform the

target behaviour was created. These factors were ranked on their relevance and the appropriate technology was chosen for the project. Then, an online experiment was done and a focus group was held to investigate the influence of different appearances of an ECA, different health-behaviour goals, preference of an ECA, personality traits of an ECA, persuasiveness and intention to use. Thereafter, the PACO application and the ECA were developed and the preparation for the evaluation of the ECA was done, this included a usability study amongst older adults (Groot, 2020). The PACO project is currently in the following phase: the PACO app will be evaluated on determinants of use and effect. Finally the dissemination will take place, in which the insights gained from the project will be communicated to the scientific world, the design industry, the care sector and older adults.

### **3.2 The PACO application**

The PACO app consists of two ECAs and five modules. Figure 3 on the next page shows the PACO app homescreen. The two ECAs are Ellen and Herman, who take on different roles within the app. Ellen guides users through the modules, while Herman's task is to discuss all food-related topics with users. The ECAs can have daily dialogues with users on multiple topics, which will motivate, inspire and create rapport. The previously mentioned modules are:

- 'Mijn voeding' (food diary): Users are asked to complete the diary, and provide information on their intake, their company, preparation, and experience.
- 'Doelen' (goals): Users can choose from predefined goals and create their own action plan. Examples of such goals aimed at improving social environment are video calling someone, inviting someone to eat together and using the chat module.
- 'Receptenboek' (book of recipes): This module enables users to choose a tailored recipe, based on their own preference. This includes both their dietary preferences and what they are craving at a certain moment. The recipes are from 'het Voedingscentrum'.

- ‘Verhalen’ (stories): Users can listen to recorded stories from other older adults about their social activities. Examples of such social activities are joining a knitting club, doing a painting course or partaking in walking football. This module also contains information on how to sign up for these social activities.
- ‘Chat’: This module enables users to communicate with other members of their group. Rocketchat is the chat box used in this module, which users have to install separately from the PACO app itself.

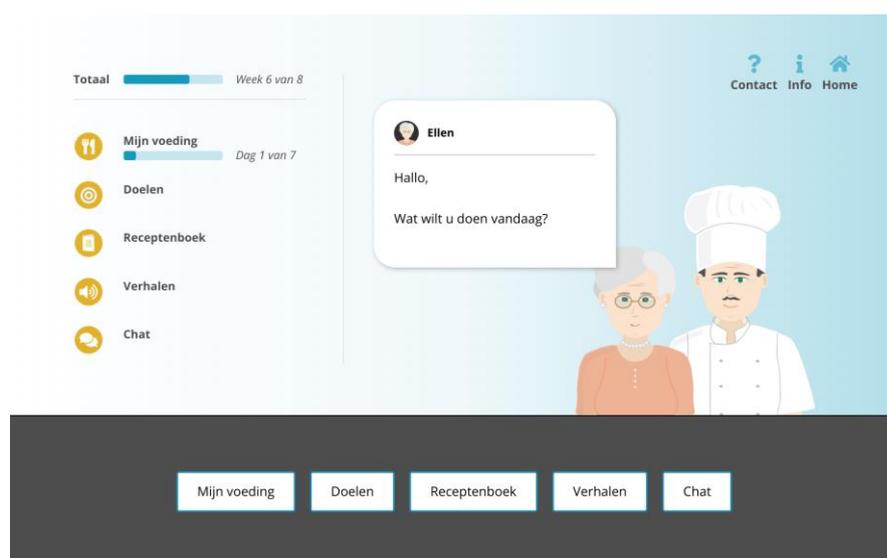


Figure 3. PACO web app, home.

### 3.3 PACO Pilot Study Evaluation

This study would have been part of a larger PACO evaluation in which the app would have been tested. Due to disapproval from the Medical Ethics Committee (METC), this larger evaluation had to be postponed. To still be able to contribute to the PACO project with this research, the PACO Pilot Study evaluation was created. Furthermore, the corona measures in place at that time made the initial setup of the larger PACO evaluation impossible. Therefore, this pilot study was adapted to make the evaluation possible during the corona crisis. It was completely digital and the modules, explained in the previous paragraph, have been changed,

so that it did not stimulate or require older adult users to meet physically. For example, within the goals module, a goal will not require older adults to meet physically but only require the use of video calling to come into contact with others.

The PACO Pilot Study evaluation of the ECA and the PACO app is split into two different studies which focus on different modules of the app. This study, being one of these two studies, focuses on experienced levels of loneliness amongst older adult users, the relationship with the ECA and user experience. This study focuses on the modules goals (all goals relevant to loneliness), stories and chat of the PACO app. The second study focuses on eating behaviour amongst older adults. It focuses on the modules food diary, goals (all goals relevant to eating behaviour), and the book of recipes of the PACO app. This will be done by another researcher and will not be included in this study.

### **3.4 PACO Pilot Study and theoretical framework**

The different concepts and mechanisms described in the theoretical framework, have been integrated in the PACO app. How the integration applies to the PACO app is explained below.

The PACO app uses ECAs to coach participants through the modules. This creates an autonomy supportive climate, in which participants are free to use the app how they want, which encourages and facilitates them to engage in healthy behaviours and to achieve success. The modules participants can use have integrated BCTs, this could lead to higher levels of autonomy and relatedness, which could reduce loneliness amongst older adults. Three modules of the ECA are relevant for reducing loneliness. These modules are goals, stories, and chat. For the goals module action planning is applied. Action planning in the PACO app is a combination of goal setting and action planning. Users are expected to define a goal about the behaviour they want to achieve. Subsequently, they will plan the target behaviour or action in detail,

which includes the context (when and what time) and the frequency. They will then try to achieve a positive outcome of the target behaviour. For the stories module social learning is applied. Social learning is a form of social support, which will make users more motivated to participate in social activities. They learn from others who are performing a target behaviour, through the audio fragments with stories of older adults participating in various social activities. For the chat module social facilitation is applied. In the chat module, users are able to interact with other users from their group. This will provide users with the knowledge that other users are performing the behaviour along with them, which will motivate to perform the target behaviour themselves.

## 4. Method

### 4.1 Study design

To investigate the effects of the ECA on loneliness amongst older adults, a mixed method approach was used. It was an exploratory pilot study. Quantitative data gathering started with the intake questionnaire (Ti) as soon as an older adult signed up for the study. Then, from the start (T0) until week 8 (T2) quantitative data in the form of log data was gathered, and after 4 weeks (T1) in the form of a user experience questionnaire. Qualitative data was gathered after 4 weeks (T1) using semi-structured interviews. To clarify, a visual representation of the study design is shown in Figure 4.

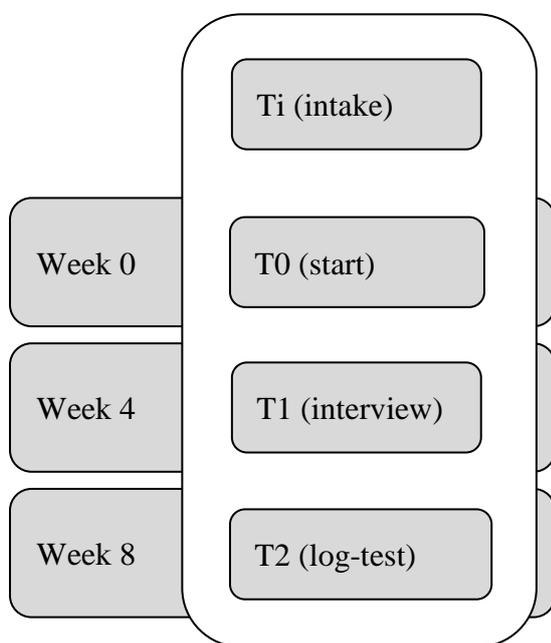


Figure 4. Study design PACO Pilot Study.

### 4.2 Recruitment and participants

Based on feasibility considerations and the explorative nature of this study, the aim was to recruit twenty older adults. The study population consisted of older adults, living in the Netherlands. Inclusion criteria were; the participant is 60+ years old, lives independently at home without a partner and does not have a paid profession. Participants need to meet the following criteria to be able to use the PACO app; a participant speaks Dutch (PACO app is in

Dutch), owns, and is able to use a tablet, laptop or computer and has internet connection at home. Participants were recruited with the following strategies:

- Participants were recruited through the social networks of the two researchers. This was done via social media and other networks. These networks consist of family, friends and other acquaintances which are from the areas of The Hague, Ommen and Wageningen. Within these networks, people were approached and asked whether they know older adults who would be suitable to participate.
- Community centres in the areas of The Hague, Ommen and Wageningen were approached via e-mail and telephone. They were asked to send e-mails to their members.
- After the previously mentioned strategies, snowballing was used. When older adults signed up to participate in the study, they were asked whether they knew other older adults that could be approached or whether they had networks that were useful.

### **4.3 Procedure**

Due to the circumstances surrounding the coronavirus, the study was conducted entirely online. When an older adult wanted to participate in the study, he or she received an email containing a link to an information letter and informed consent form on Qualtrics (Appendix A). After providing informed consent, the intake questionnaire followed. Subsequently, participants received an e-mail containing a manual on how to use the PACO app, a welcoming video which also explains the PACO app shortly and a manual on how to install and use Rocketchat. In the first week, when a participant started using the PACO app, one of the researchers called to ask if the participant had any questions or concerns left. During this call, participants and researchers agreed on a date to conduct the interview. After 4 weeks, participants were interviewed and filled out the user experience questionnaire. Inactivity on the

PACO app for more than 5 days, resulted in a call from one of the researchers to ask why the participant had stopped using the app. If participants experienced difficulties during the study, they could contact the researchers via e-mail or the contact form in the PACO app. All communication was kept in a digital logbook. Software related problems were communicated to the RRD.

#### **4.4 Data collection**

The intake questionnaire consisted of questions about demographics, health issues and which device they were planning to use the PACO app on (Appendix B). Log data on user ID, timestamp, dialogue name, speaker, utterance, goal achievement and chat history was tracked throughout use of the app. The user experience questionnaire included 5-point Likert Scale measuring instruments: Perceived Enjoyment (Cheung, Chang & Lai, 2000), Perceived Usefulness (Heerink et al., 2010) and System Usability (Brooke, 1996). Also, 7-point Likert Scale measuring instruments were included: Aesthetics (Lavie & Tractinsky, 2004), Privacy Concerns (Chellappa & Sin, 2005) and Control (Liu, 2003). Besides that, the questionnaire asked for Willingness to pay. The full questionnaire can be found in Appendix C. In-depth interviews were conducted via telephone and focussed on subjective experience of the PACO app and the effects of the PACO app on loneliness. The interview questions were based on the conceptual model of an ECA reducing loneliness from Figure 2. Examples of questions asked are: “What was your experience with the stories module?” and “Did your social contacts change when using the application?” The interviews were semi-structured and took approximately half an hour. In Appendix D, an overview of the interview schematic can be found. Table 1 contains an overview of the different measuring instruments and when these measuring instruments were used for data collection for the PACO Pilot Study.

All data is stored according to the Data Management Plan (DMP) of the PACO project, which was created in cooperation with the Wageningen Data Competence Centre. This is in line with the WUR privacy policy and regulations.

*Table 1. Data collection overview.*

Data collection overview	Period			
Measuring instrument	Ti	T0	T1	T2
Intake questionnaire	■			
User experience questionnaire			■	
Interview via telephone			■	
Log data		■	■	■

#### 4.5 Data analysis

The log data was analysed using a simple method; counting occurrences. All log data was uploaded into Excel, which was then used to analyse and calculate time spend on a certain component/module, time spend on the app in total, the amount of dialogues a user got through, occurrences of interaction with the ECAs Ellen and/or Herman, set and achieved goals and in which manner the chat function was used. Data from the questionnaires was uploaded to IBM SPSS Statistics 26. Means, medians and standard deviation of the items were calculated. The interviews were conducted and transcribed by two different researchers. Subsequently, the transcribed interviews were coded by one researcher. For the coding process, top-down coding was used. The coding scheme for the top-down coding is based on the conceptual model in Figure 2. Codes were added to the existing coding scheme if the researcher noticed certain themes stood out in the interviews. The coding scheme can be found in Appendix E. The interviews were analysed with Atlas.ti 9.

#### **4.6 Ethical considerations**

An informed consent form had to be signed by participants before joining the study. Subjects were able to leave the study at any time for any reason if they wished to do so without any consequences. Participants were not exposed to any risks, nor did they have any costs. They contributed to the development and design of a new technology in the health care sector. At the end of the PACO pilot study, participants received a box of chocolate with a handwritten thank you note.

The research protocol for the PACO Pilot Study was approved by the Social Sciences Ethics Committee (SEC) of Wageningen UR on 2 July 2020 with CoC number 09215846.

## 5. Results

In this result section an overview of the results of the PACO Pilot Study evaluation will be given. Firstly, the demographics of participants will be given. Secondly, the results will show older adults' use of ECAs with the log data. Secondly, user experience will be shown with data from the user experience questionnaire and partly with data from the interviews. Lastly, the influence of the ECA on loneliness amongst the older adults will be shown with data from the interviews.

### 5.1 Demographics

In total 10 older adults participated in the PACO Pilot Study. 2 participants quit before the 4 weeks of using the PACO app ended. These participants quit on the first day of the study, because they found installing the app to be overwhelming and too much work. The other 8 participating older adults ranged in age from 60 to 82 ( $M=75.25$  &  $SD=8.53$ ). All participants were female (100%) and able to leave their house independently (100%). Most of the participants completed secondary education as their highest education (6 out of 8), 1 participant completed higher vocational education and 1 participant finished primary school. All participants used their own device, with most participants using a laptop/computer for the PACO app (5 out of 8) and others using a tablet (3 out of 8). None of the participants indicated to have dementia and none of them indicated to be unhappy.

### 5.2 Use of ECA

Participants had different patterns for using the PACO app. Three participants used the app everyday steadily during the 4 weeks. Of these three participants, one participant used the app multiple times a day, up till 5 times a day. Three other participants started with using the app daily, but after two weeks, decreased to once every 2 to 4 days. Two other participants used the app once every 2 to 3 days from the beginning of the study. Although these using

patterns are different, all use patterns declined after a couple of weeks. Almost all participants spend more time on the app at the beginning of the 4 weeks. After 8 weeks (between T1 and T2), none of the participants used the app.

During the day, the hour at which participants would use the app differed. One participant used the app multiple times a day, after each meal and/or snack to fill in the food diary. Another participant only used the app during the evening and two participants used the app only during the day. The other four participants did not use the app during certain hours of the day. This shows that some participants had created moments during the day to use the app, while others did not show a pattern of when they used the app.

In Table 2, a summary of the log data can be found. The total amount of time spent on the app differs between participants, with 2:04:55 being the least amount of time spent on the app and 9:46:01 being the most time spent on the app ( $M=5:06:00$ ,  $SD=2:26:16$ ). Remarkable is the amount of sessions a participant had in the app in combination with the total amount of time spent on the app. Some participants went through the dialogues and modules a lot faster than others. For example, participants pa-viool and pa-zonnebloem both had 20 sessions on the app, but pa-zonnebloem used the app for almost 3 more hours than pa-viool. Besides that, 5 out of 8 participants went through the explanation of the chat. However, none of them installed the chat.

*Table 2. Log data summary.*

	Sessions	Total time sessions	Interactions	Home Dialogues	Set goals	Stories
pa-jasmijn	24	3:12:31	986	4	0	1
pa-klaproos	141	9:46:01	1763	0	0	0
pa-klaver	23	2:54:23	926	1	2	4
pa-lelie	32	5:45:27	2323	0	0	0*

pa-margriet	42	6:08:28	1803	0	2	0*
pa-tulp	25	5:59:06	1369	0	0	3
pa-viool	20	2:04:55	738	1	0	0
pa-zonnebloem	20	4:57:10	1170	5	0	0

\*These participants wanted to listen to a story, but because of technical difficulties they could not. These technical difficulties were discovered after the 4 weeks of using the app.

Did not finish 4 weeks:						
pa-lavendel	1	0:09:00	75	0	0	0
pa-paardenbloem	1	0:21:08	60	0	0	0

### 5.3 User experience

The user experience questionnaire contains data on Perceived Enjoyment, Perceived Usefulness, Aesthetics, Privacy Concerns, Control, System Usability and Willingness to Pay. Table 3 shows a summary of this data. Perceived Enjoyment was rated neutral to positive by all participants. For Perceived Usefulness some participants rated the app as useful, others rated more negatively on this element. Overall, Aesthetics were rated positively by participants. However, one of the participants disagreed with the statement: PACO looks aesthetic. Participants disagreed on privacy concerns. While three participants are not worried at all, three participants are neutral and one participant is quite worried about her privacy concerns when using the PACO app. On a scale of 0 to 100, participants evaluated the overall system usability as 'good' with a score of  $M=70$ . When it comes to system usability, only one participant indicated to have difficulties with using the PACO app. Although, this is also the only participant that indicated to want to use the app in the future. All other participants do not plan on using the app in the future. None of the participants are willing to pay for the PACO app.

*Table 3. Summary user experience questionnaire.*

	Mean	Standard Deviation
Perceived Enjoyment	3.89	0.78
Perceived Usefulness	3.43	0.83
Aesthetics	5.74	1.21
Privacy Concerns	3.39	1.49
Control	5.12	1.23
System Usability	70	9.90

During the interviews, almost all participants indicated they had difficulties with using the PACO app in the beginning of the 4 weeks evaluation. The two participants who stopped using the app were also shortly interviewed and they said they were overwhelmed. They found installing the app too difficult and too much work. Two other participants were not able to install the app themselves. One of the researchers visited these participants at home to help them with installing the app. Both these participants commented they would have quit the PACO evaluation if they would not have had help from the researchers. Other participants reached out to the researchers in the first few days of using the app, because something was unclear to them or because they had technical difficulties. For example, one participant was not able to get to the website of the PACO app, even if she clicked on the link in the introductory email. During the four weeks of using the PACO app, participants ran into some other problems. Something that multiple participants found to be difficult was not being able to go back to a previous webpage. For example, if they accidentally clicked on the wrong answer

when having conversations with the ECAs, they were not able to go back to correct their mistake. The same participants also said they could not correct mistakes.

User experience with the PACO app differed between participants. While most participants found the app to be simple and easy-to-use, few participants did not like using the PACO app. Reasons that were given for not having good user experiences were: not liking the pre-set up questions and answers, being bored by always having to fill in exactly the same thing and having difficulties with using the app. However, most participants referred to the app as simple and easy-to-use.

*“I experienced using the app as very simple. I thought it was all very clear and using the app was easy.... I almost did not have to think about it, it went really well.”*

When asked why using the app was simple, participants answered that the setup of the app was understandable and the pre-set questions and answers made it easy. The youngest participant even mentioned that she felt the app was too simple and easy. While using the app she felt like she was not the right target group for the app. She described herself as an advanced technology user and that this app is more suited for elderly who are not familiar with technology.

#### **5.4 Relationship development**

Experiences with the development of a relationship with the ECA differed between the participants. How participants experienced this, can be classified into three categories; (1) participants who experienced the ECA as an addition to the app; (2) participants who experienced the ECA as unnecessary, and; (3) participants who did not consciously experience the ECA being present in the PACO app.

The ECA was experienced as an addition to the app by two participants. These two participants both liked having the virtual agents to communicate with. Having the virtual agent to communicate with made using the app more personal. They felt as if they were actually talking to the virtual agents and as if they were able to tell their story to the virtual agents. Both these participants found no difference between Ellen or Herman, although they did have more conversations with Ellen.

*“It becomes a bit more personal, normally whenever I do something on my computer it is impersonal. However now I was really doing it for Ellen. That is way more fun than just doing it for an institution with just a name.”*

Five participants experienced the ECA as unnecessary. Multiple participants stated that the ECAs were not an addition to the app. Three participants even stated that the ECAs were a hassle. The way of questioning by the ECAs and the multiple choice answers were tedious and monotonous. Also, one participant simply was not interested in chatting to the ECAs, so she consciously made the decision to make no use of the dialogues provided by the ECAs. She only interacted with them when necessary, in the different modules.

*“You had to click which would then start a conversation... (with Ellen or Herman) ..., but I decided not to use that.”*

Two participants did not consciously experience the ECA being present in the PACO app. These were participants that had difficulties with using the app. When asked about their experience and opinion on the ECAs, they did not have a clear answer. For them it added nothing to the app.

The five participants that experienced the ECA as unnecessary, did not develop a relationship with the ECA. Participants that did experience the ECA as addition to the app, also did not indicate they felt like they had developed a relationship with the ECA. They all

indicated that interacting with the ECA did not influence their loneliness. Almost all participants said that they did not feel lonely in the first place. However, some participants did say they could imagine an ECA helping other older adults who do feel lonely.

### **5.5 Behaviour Change Techniques (BCTs)**

Participants indicated they did not actively use the BCT action planning in the goals module to set goals regarding their social environment. Not feeling the need for setting goals and feeling like it would not help them were the most mentioned reasons by six participants. Some reasons were only mentioned by one participant. For example, one of the older participants felt like it was too difficult and complex for her, she was afraid of making mistakes. Another reason that was given by a different participant was her stubbornness, not wanting help from an app and wanting to do it all on her own. Also, one participant felt like setting goals to improve social contact during the corona crisis was irrelevant and was therefore not interested in this module.

Experiences with the BCT social learning in the stories module differed. Three participants did not use the stories module at all. Two participants said they clicked on a story, but nothing would happen. It seemed like the app crashed, a technical difficulty. The other participants actually listened to stories in the module. Although they liked it, it did not have any effect on them, and they did not feel the need to use it more. Multiple participants said they already have enough social contacts and do not need an app to help them. Also, one participant mentioned the inconvenience of participating in the social activities displayed in the stories module:

*“When someone talks about a boat trip my thoughts go: this would be fun to do with friends. Everyone is already in their own circuit and has their own friends. It should be people who live near you, with whom you can easily make contact.”*

The chat, which contained the BCT social facilitation, was not installed or used by any of the participants. Some participants did not use the chat, because they did not really understand or were unaware the app contained a chat. All of the other participants said they did not feel the need to use this part of the app. Most of them felt like they already had enough social contacts and did not need the chat to create new social contacts. One of the younger participants did not like using other communication channels like WhatsApp or Facebook either. Besides that, participants mentioned that once they saw what they had to do to install the chat, they found it to be difficult and too much work. Also, one participant felt like it was weird to chat to people they had never met before. One participant mentioned she would be more likely to use the chat if she knew she could chat with people that were in her close environment.

### **5.6 Autonomy, relatedness and loneliness**

An effect that was expected to follow from the BCTs was participants feeling autonomous in creating the social environment they desire. The modules that contained these BCTs were not used often or not at all. Participants felt like their social environment had not changed. Therefore autonomy did not contribute to any changes in feeling less lonely. However, two of the participants indicated they already felt autonomous, they already have the knowledge of the things explained in the app and freedom to choose and be able to arrange their own social environment. Therefore they did not use some of the modules.

Another effect that was expected to follow from the BCTs was participants having higher feelings of relatedness, because of the social connections they would make. This should reduce loneliness. However, all participants said their social contacts did not change as a result of using the app. Most participants mentioned they did not have a need for more feelings of relatedness. These feelings of relatedness are already satisfied with their existing social environment and social contacts.

## 5.7 Other

None of the participants thought they would have used the PACO app differently if the corona crisis would not be going on. Some of them realised that they would have used the app differently if they would have focussed more on the social contact part of the app. One participant mentioned how the activities in the stories module were impossible to do during the corona crisis, since lots of activities got cancelled.

*“I was not interested ...(in joining a knitting club)..., but you could also do a bridge club for example. However, all of these activities were not there at that moment (when participants were using the PACO app). During the corona crisis everything got cancelled.”*

Also, one of the participants said that constantly having to fill in the food diary module, typing she was eating alone, was confronting. In normal circumstances, she would have had meals with others more often. Despite most participants not thinking they would use the app differently under normal circumstances, most participants did say that their social environment was different during the corona crisis. Participants had empty agendas, did not do any social activities and stayed mostly at home.

Multiple participants stated they did not feel like they were the target group of the PACO app. Although they liked using the app, they felt like they were already eating somewhat healthy and were not lonely in their social environment. These participants felt like they were not the right participants to actually notice any effects from using the app. Especially the younger elderly participants felt like they were too young to be using an app like the PACO app.

*“I think the target group of the app should be a lot older, because a lot of older elderly are lonely. I think I am too young, you should look for people around the age of 80.”*

However, participants did mention they could see the PACO app working for other elderly people who are lonely and eat unhealthy. One of the participants said her mother, who is 87 would be a perfect candidate to participate in research like this. The only problem is that she does not know anything about technology.

## 6. Discussion

The aim of this research was to investigate how the use of ECAs can influence loneliness amongst older adults. In this discussion the research question and sub research questions from chapter 1.4 are answered. This is done with a conclusion of the results, comparing the results from this study to results from other studies with similar research questions, discussing the limitations and strengths of this study and recommendations for future research are made.

### 6.1 Main findings and comparison with literature and theoretical framework

The overall main finding is that the results do not support the conceptual model of an ECA reducing loneliness in Figure 2. The ECA did not have an effect on loneliness amongst older adults. Although in this PACO Pilot Study, loneliness was not reduced amongst older adults, the researchers still expect that an ECA could reduce loneliness for older adults. In this study, the older adults participating did not feel lonely, with others who do feel lonely, the app could still be successful. In the following paragraphs, the other findings, which led to this main finding will be presented.

The first finding is that older adults develop three different usage patterns and habits when using ECAs. The first usage pattern is using the app three or more times a day, after every meal or snack, the second usage pattern is using the app once a day and the third usage pattern is using the app once every two to three days. These usage patterns mostly form because older adults got into a habit of filling in their food diary at a certain moment. Although older adults have different usage patterns, they all had to get used to the app in the beginning and they all stopped using the app after the 4 weeks of the study. In literature, information on usage patterns and non-continuance of use of eHealth applications is limited, especially for older adults (Krebs & Duncan, 2015). This could be due to the fact that although many ECA interventions are

targeted at older adults to improve their health, not much of this research included log data (Kramer et al., 2020). More log data research on ECAs to improve health could give better insights on use and usage patterns.

The second finding is that user experience is positive. The PACO app was received well by older adults and user friendliness was experienced high. With the exception of some minor (technical) issues, and having to get used to the app in the beginning, older adults found it fairly easy to use the app. Overall, older adults rated system usability of the ECA as good ( $M=70,0$ ). Earlier research which solely focussed on the usability of the PACO app had similar findings with system usability rated  $M=72,0$  (Groot, 2020). Li and Luximon (2018) concluded the same in their research about usage behaviour and perceptions of mobile technology amongst older adults. According to them: “They (older adults) generally demonstrated positive attitudes toward mobile technologies but also reported the complexity of technologies.”

The third finding is that ECAs were experienced in 3 different ways by older adults. These three different experiences were: the ECA is an addition to the app, the ECA is bothersome or the ECA was not consciously experienced. However, none of the older adults indicated to have developed a relationship with an ECA. Therefore, nothing can be said about whether and how this relationship influenced loneliness. Montalvo (2017) investigated the opportunity of ECAs in serving as a social companion for older adults. He concluded that because some social components are low for ECAs, this could negatively affect the possibility of a relationship. This social component is mainly social contagion and can be improved by adding facial expressions of smiling, care and concern to the ECA. Sidner et al. (2018) did similar research and could not be as conclusive as they had hoped for. However, participants in their study indicated the ECA provided companionship and social support. Both Sidner et al. (2018) and Montalvo's (2017) studies indicate the potential of ECAs and older adults creating relationships. This is in line with Figure 2 the conceptual model of an ECA reducing

loneliness, in which loneliness is reduced by the development of a relationship between user and ECA.

The fourth finding is that the majority of older adults did not use the modules that included the BCTs action planning, social learning and social facilitation. Reasons for not using these modules were finding it too difficult, not feeling the need, being stubborn, and feeling like that part of the app was not for them since they do not feel lonely. The action planning module was not received well by the older adults. The pre-set goals were found to be simple and not suitable. Previous research has shown similar outcomes, with older adults not using technology designed to support self-tracking, which is a huge part of action planning (Caldeira & Chen). According to Caldeira & Chen (2019), this is due to the fact that a gap exists between what is assumed to be older adults' needs, interests, goals, and practices and what is actually offered to them with the apps currently available. Some older adults did use the stories module (social learning), and although they thought it was not for them, they liked the setup of the module. They thought it could be useful for older adults that do feel lonely. Sidner et al. (2018) had a similar set up of their app as they had the ECA "talk with users about activities designed to provide companionship and to reduce isolation through digital connections to friends and family and to the physical community." They also found that participants did not feel like they were the right target group, as they did not need that companionship. Besides that they found that this stories module was one of the least used modules in their study. The chat module (social facilitation), was not used by any of the participants. Although most did go through the explanation of the chat, they consciously decided not to install the chat. This was mostly because they found it too difficult to install or they did not want and feel the need to talk to the other older adults participating in the study. However, online social interaction has been proven to reduce loneliness in past research. Nowland et al. (2018) state: "when the Internet is used as a way station on the route to enhancing existing relationships and forging new social

connections, it is a useful tool for reducing loneliness.” In the case of apps such as PACO the aim of the chat is to let the users connect with each other and form new connections. Therefore, a chat module containing the BCT social facilitation does have great potential. Only the older adults need to be open to using the chat and connecting with new people. According to Cipolla (2020), for this to happen older adults need to understand the usefulness of such a chat module. Also, the chat has to be suitable for older adults and easy to use.

The fifth and last finding is that results from this study cannot confirm that feelings of autonomy and relatedness influence loneliness. The older adults indicated that they did not change anything in their social contacts due to the app, therefore loneliness was not influenced. Hence, nothing can be said about how feelings of autonomy and relatedness influenced loneliness. Literature on autonomy and its influence on loneliness is scarce. However, Chua and Koestner (2010) found that individuals who autonomously choose to spend time alone have lower levels of loneliness. In addition, previous research shows that loneliness can be reduced if an individual’s desire for relatedness is fulfilled by connecting with others (Cacioppo et al. 2002). Chua and Koestner (2010) and Cacioppo et al. (2002) show that higher levels of autonomy and relatedness could reduce loneliness.

## **6.2 Limitations and strengths**

All older adults indicated the measures taken and the situation surrounding the coronavirus did not influence their use of the PACO app. However, the researchers suspect that it could have influenced it; people spend more time at home, meaning they had more time on their digital devices and physical social contact was reduced to a minimum for older adults. Furthermore, the coronavirus influenced the set-up of the PACO Pilot Study. In order to keep all participants safe, it was decided everything had to be done online, meaning participants had to install the app by themselves. Although this new online set-up was not ideal, it created a

more realistic situation. It is similar to how older adults would have to install the PACO app when it would be available in an app store.

Another limitation was found during the recruitment of participants. It was difficult to find elderly people who belonged to the target group and wanted to participate in the study. Eventually, the researchers were able to find ten people that wanted to participate. Hereby, decreasing the amount of participants, since the initial aim was to recruit twenty older adults. The older adults that participated did not necessarily need the use of an app such as PACO. It was found that people who were already eating healthily and already had social contacts were most willing to participate. Older adults that might have been the right candidates for using the PACO app did not want to participate. They were either too scared to use a new technology or they did not view themselves as suitable for this study.

A strength in this research is the three different types of data gathering. With interviews, log data and a user experience questionnaire, both quantitative and qualitative research were used to get the best overview of how the PACO app and the components it contains could influence loneliness. Furthermore, these different ways of data gathering support findings from different angles. For example, the findings of the user experience questionnaire are confirmed with the results from the interviews. The interviews especially gave an in-depth and detailed overview of the older adults' experiences and opinions towards the app. In-depth interviews are rare in ECA research, but therefore all the more important. Besides the details that come to light from the interviews, it is also a way to involve older adults in designing the ECA that is ultimately meant for them.

This PACO Pilot Study is especially valuable for the larger PACO project. This study already gives an insight on the mechanisms of the PACO app and how older adults react to them. Also, during this study, issues came up which can be avoided or easily fixed with taking minor steps. For example, technical difficulties were fixed for the larger evaluation, which can

really influence the results of an evaluation. This has resulted in recommendations for the PACO project, which can be found in chapter 6.3. Besides this study helping the large PACO evaluation, this study can also be used as a base for future research regarding ECAs and reducing loneliness. While research about improving health with ECAs is becoming more and more popular, ECAs reducing loneliness is still in the beginning stages and needs more extensive research.

### **6.3 PACO recommendations**

A lot was learned from the PACO Pilot Study, whereby recommendations were established for ECA interventions. All recommendations include a more specific recommendation for the PACO project. The following recommendations were drafted:

1. During the recruitment phase of the PACO Pilot Study, it became clear that finding people from the target group who wanted to participate was difficult. Older adults often did not respond to emails or WhatsApp messages and when they did respond, the answer was mostly 'no'. However, approaching older adults personally, so via phone call or face-to-face, worked better and generated more older adults answering with 'yes'.

For the larger PACO evaluation it is recommended that the researchers try to get the telephone numbers of potential participants. This way the researchers can approach the older adults personally by calling them instead of sending a message.

2. The app had some technical difficulties. Firstly the app contains a contact form which users can fill out if they have any questions or remarks. These forms were sent to the email address of the head of the PACO project. However, these messages ended up in the junk email folder, which meant some questions were not noticed by the researchers in time. Secondly, the stories module in the PACO app was not working for Apple

devices. The sound did not work and the system sometimes crashed. This meant the participants had to log in again. In order to avoid issues like this in future ECA research, all functions within an app should be tested before an evaluation starts, even if it seems irrelevant or unnecessary.

For the larger PACO evaluation, it is recommended to change the settings so that all the messages from the contact form can be seen and answered immediately and so that all functions work on all devices. Also, all other functions should be tested before the larger evaluation starts to avoid similar issues.

3. The chat module was not used by any of the participants of the PACO Pilot Study, because it was too difficult and too much work to install. Future ECA interventions with a chat should try to integrate the chat function within the app itself. This way users do not have to go through the trouble of installing another separate app only to be able use the chat. What could be helpful is a small group of potential users going through all functions on the app, to see how the functions in the app are received. Based on the experiences of these potential users, functions can be changed.

For the larger PACO evaluation it is recommended to make the chat more easily accessible. For example, make the chat an in-app feature or use a chatroom provider that the majority of participants already use, like WhatsApp.

#### **6.4 Future research**

Firstly, future research should focus on strengthening theory about ECAs reducing loneliness. We think that current research testing and evaluating ECAs is not reaching its full potential. Lots of different ECAs have been and are being designed for different projects, with similar goals. Designing such an ECA is a long process and costs a lot of time and money. With designing so many different ECAs, time and money are being wasted. For ECA research to

reach its full potential, ECAs should be tested for a longer period of time and the long-term effects should be evaluated. The idea behind this is to create a basis for an effective ECA, which can be used in all future ECA research.

Secondly, future research should also focus on a more advanced ECA. Reducing loneliness in older adults might be more likely to happen if the ECA is more advanced. The PACO app contains a cartoon like ECA, which interacts with the older adults through text. However, in other research ECAs have already been designed with a lot more characteristics. For example, other designed ECAs have the ability to speak or have more human-like features. Human-like features in this case include facial expressions, emotions and having a character (Cassell et al., 2000). In addition, interaction within the different modules should be more diverse. For example, in the food diary module users had to go through the same conversation with the ECA every time they filled out their food diary. With this constant repetition, the ECA is not viewed as a human-like social interaction, but rather a computer talking to them.

## **6.5 Conclusion**

This research has explored the main research question: “How do ECAs influence loneliness amongst older adults?” In conclusion, the conceptual model in which the BCTs action planning, social learning and social facilitation create higher feelings of autonomy and relatedness, which in turn will reduce loneliness amongst older adults cannot be validated. Although user experience of the app was positive, the BCTs were not used extensively and no older adult developed a relationship with the ECAs. Furthermore, the older adults did not feel lonely in the first place and therefore did not feel a need to use the modules which aimed to reduce loneliness. However, older adults were positive about ECAs for others. They thought it could be very helpful for older adults who do feel lonely. Also, other previous research shows the potential of ECAs reducing loneliness amongst older adults.

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# Appendices

## Appendix A. Consent form

### Informatiebrief PACO

Voordat u beslist of u wilt meedoen aan dit onderzoek, krijgt u uitleg over wat het onderzoek inhoudt. Leest u deze informatie rustig door en vraag de onderzoeker om uitleg als u vragen heeft. U kunt zich tot uiterlijk 29 juni 2020 aanmelden om deel te nemen.

#### 1. Algemene informatie

Dit onderzoek maakt deel uit van een project dat wordt uitgevoerd door Wageningen University & Research, in samenwerking met het Nationaal Ouderenfonds, WAAG en Roessingh Research and Development. Het project wordt gefinancierd door ZonMw, de Nederlandse organisatie voor gezondheidsonderzoek en zorginnovatie. Voor dit onderzoek zijn we op zoek naar 20 proefpersonen. U kunt meedoen als u aan de volgende criteria voldoet:

- U beoefent geen betaald beroep
- U bent 60 jaar of ouder
- U woont alleen (dus zonder partner)
- U bent thuiswonend (en dus niet in een zorg- of andere instelling)
- U bent in het bezit van en kunt met een tablet, laptop of computer omgaan
- U beschikt thuis over een wifi netwerk

#### 2. Doel van het onderzoek

In dit onderzoek gaat u de PACO-app gebruiken. Deze app is bedoeld om u te ondersteunen bij een gezonde levensstijl. PACO bestaat uit twee virtuele coaches en verschillende modules om sociaal contact en eetgewoonten onder ouderen te verbeteren. Het doel van dit onderzoek is om te achterhalen hoe de app wordt gebruikt, wat de gebruikerservaringen zijn en wat het betekent voor de gezondheid van gebruikers.

#### 3. Resultaten onderzoek

De resultaten uit het onderzoek verwerken wij om te kunnen beoordelen of elektronische toepassingen, zoals de PACO-app, een positieve bijdrage hebben op de gezondheid van oudere gebruikers. De resultaten van dit onderzoek zullen worden opgenomen in het PACO

project en zullen worden gebruikt voor de masterscripties van twee studenten van Wageningen University & Research. Hierbij zullen alle onderzoeksgegevens geanonimiseerd worden.

#### **4. Achtergrond van het onderzoek**

Uit wetenschappelijke literatuur is gebleken dat er nog te weinig bekend is over het gebruik en de toegevoegde waarde van elektronische toepassingen, waarbij gebruik wordt gemaakt van virtuele coaches. Het is belangrijk om hier inzicht in te verkrijgen, zodat we deze kennis kunnen verspreiden en toepassen in bestaande of nieuwe elektronische toepassingen.

#### **5. De PACO-applicatie**

De PACO applicatie bestaat uit twee virtuele agents Ellen en Herman die u gedurende het gebruik van de app ondersteunen. Daarbij heeft de applicatie vijf verschillende modules die u kunt gebruiken. Het hoofdscherm van de applicatie is te zien in Afbeelding 1. De modules worden hieronder opgesomd en uitgelegd.

- ‘Mijn voeding’ is een module waarin u gedurende 7 dagen een voedingsdagboek invult. Daarbij kunt u ook invullen met wie u was, wie het heeft bereid en in hoeverre u ervan genoten heeft. Het doel van deze module is om meer inzage te krijgen in uw voedingsgewoonten, hieruit volgt dus geen advies.
- ‘Doelen’ is een module waarin u een doel met betrekking tot eten of sociaal contact kunt opstellen. Deze module bevat een lijst met doelen waar u uit kunt kiezen, welke gebaseerd zijn op eerder onderzoek. Samen met de ECA kiest u doelen die bij u passen en maakt u een specifiek actieplan, met daarin wanneer en hoe lang u aan een bepaald opgesteld doel wilt werken.
- ‘Receptenboek’ is een module waarin u op maat gemaakte recepten kunt vinden, gebaseerd op uw eigen voorkeuren en allergieën. Deze recepten komen van het Voedingscentrum
- ‘Verhalen’ is een module waarin u kunt luisteren naar verhalen van andere ouderen die sociale activiteiten hebben gedaan. Ook sociale activiteiten die u kunt doen in

quarantaine komen aan de orde. Deze module bevat naast de verhalen ook informatie over hoe u aan de slag kunt met dezelfde of eenzelfde soort activiteit.

- ‘Chat’ is een module waarin u contact kunt hebben met de andere deelnemers. In de chat zullen ook de virtuele agents zo nu en dan een vraag stellen.

## **6. Wat wordt er van u verwacht**

Als u meedoet, vragen we u 4 weken lang de app te gebruiken. Daarna bent u vrij om de app te gebruiken als u dat zelf nog wilt. De onderzoekers zullen na deze eerste 4 weken nog 4 weken inzage kunnen doen in uw gebruikersdata. U kunt de app zien als een ondersteuning om uw gezondheid te verbeteren. Met ondersteuning wordt bedoeld dat we niets verplichten. U beslist hoeveel gebruik u van de app maakt. U kunt gebruik maken van de verschillende modules die in punt 5 beschreven staan.

Naast het gebruik van de app bestaat de studie uit de volgende onderdelen:

- Het invullen van een intake vragenlijst zodra u de toestemmingsverklaring online heeft getekend. Deze intake vragenlijst gaat over demografische gegevens.
- Het thuis installeren van de app. Hiervoor krijgt u een welkomstmail, met daarin een introductie video, de handleiding van de applicatie en de handleiding van de chat module.
- Het invullen van een vragenlijst van 30 vragen over uw gebruikservaring met PACO na de app 4 weken te hebben gebruikt. Deze ontvangt u via de mail.
- Een telefonisch interview, waarvoor een datum wordt afgesproken. Dit interview vindt plaats na de app 4 weken te hebben gebruikt. Tijdens dit interview wordt u gevraagd uw ervaringen over de applicatie te delen. Van het interview zal een audio opname worden gemaakt, zodat wij dit achteraf nog kunnen terugluisteren en analyseren. Dit interview duurt ongeveer een 45 minuten.
- De studie waaraan u actief deel uitmaakt duurt 4 weken. Naast die eerste 4 weken gaan we de daaropvolgende 4 weken ook nog kijken naar het gebruik van de app. Dit

is vooral om erachter te komen of u de app na het 4-weekse programma ook nog voor uzelf gebruikt.

We verwachten dat al deze onderdelen in totaal ongeveer twee uur in beslag nemen.

De studie gaat van start de maandag nadat u zich heeft aangemeld. U krijgt dan een definitieve bevestiging van uw deelname, samen met aanvullende informatie in een welkomstmail, waarna u kunt beginnen met het gebruik van de app en het invullen van de eerste vragenlijst.

Om het onderzoek goed te laten verlopen is het belangrijk dat u:

- gebruik maakt van de PACO-app;
- de vragenlijst invult;
- deelneemt aan een telefonisch interview.

Het is belangrijk dat u contact opneemt met de onderzoeker als u niet meer wilt meedoen aan het onderzoek, of als uw contactgegevens wijzigen.

## **7. Mogelijke voor- en nadelen**

Het is belangrijk dat u de mogelijke voor- en nadelen goed afweegt voordat u besluit mee te doen. Deelname aan het onderzoek betekent dat u tijd kwijt bent aan het invullen van de vragenlijst, het gebruiken van de PACO app en het telefonisch interview. Een voordeel is dat u door het gebruik inzage krijgt in uw voedingsgedrag. Daarnaast draagt uw deelname bij aan meer kennis over het gebruik van de PACO app, zodat wij die verder door kunnen ontwikkelen.

## **8. Als u niet wilt meedoen of wilt stoppen met het onderzoek**

Meedoen is vrijwillig, wel vragen we u om uw schriftelijke toestemming. Als u meedoet, kunt u zich altijd bedenken en toch stoppen, ook tijdens het onderzoek. Als u stopt, wordt u gemaïld om te vragen wat de reden van stoppen is. Als u de reden niet wilt geven, is dat ook geen probleem. De gegevens die tot dat moment zijn verzameld, worden gebruikt voor het onderzoek. Indien u uw gegevens wilt laten verwijderen, is dit ook mogelijk. Dit kunt u

aangeven bij de onderzoeker.

## **9. Einde van het onderzoek**

Uw deelname aan het onderzoek stopt als de onderzoeksperiode voorbij is;

- u de app 4 weken heeft gebruikt, en de 4 daaropvolgende weken waarin de onderzoekers inzage hebben in gebruikersdata voorbij zijn; of
- u zelf kiest om te stoppen;
- of Wageningen University & Research of de overheid besluit om het onderzoek te stoppen.

Na het verwerken van alle gegevens informeert de onderzoeker u over de belangrijkste uitkomsten van het onderzoek. I.v.m. het verwerken en analyseren van alle gegevens zal dit maximaal 4 maanden na het interview zijn.

## **10. Gebruik en bewaren van uw gegevens**

Voor dit onderzoek worden uw persoonsgegevens gebruikt en bewaard. Het gaat om gegevens zoals uw naam, leeftijd, en de antwoorden op de vragenlijsten. Het verzamelen, gebruiken en bewaren van uw gegevens is nodig om de vragen die in dit onderzoek worden gesteld te kunnen beantwoorden en de resultaten te kunnen publiceren. Wij vragen voor het gebruik van uw gegevens uw toestemming.

### Vertrouwelijkheid van uw gegevens

Om uw privacy te beschermen krijgen uw gegevens een code. Uw naam en andere gegevens die u direct kunnen identificeren worden daarbij weggelaten. Alleen met de sleutel van de code zijn gegevens tot u te herleiden. Ook in rapporten en publicaties over het onderzoek zijn de gegevens niet tot u te herleiden.

### Toegang tot uw gegevens voor controle

De leden van het onderzoeksteam hebben de mogelijkheid uw gegevens in te zien. Zij houden uw gegevens geheim. Indien er problemen ontstaan, heeft Lean Kramer van Wageningen University & Research het recht om de gegevens te controleren. Wij vragen u voor deze inzage toestemming te geven.

### Bewaartermijn gegevens

Uw gegevens worden 10 jaar worden bewaard door Wageningen University & Research.

Hierna worden de gegevens vernietigd.

### Intrekken toestemming

U kunt uw toestemming voor gebruik van uw persoonsgegevens altijd weer intrekken. Dit geldt voor dit onderzoek. De onderzoeksgegevens die zijn verzameld tot het moment dat u uw toestemming intrekt worden nog wel gebruikt in het onderzoek. Indien u uw gegevens wilt laten verwijderen, is dit ook mogelijk. Dit kunt u aangeven bij de onderzoeker.

### Meer informatie over uw rechten bij verwerking van gegevens

Voor algemene informatie over uw rechten bij verwerking van uw persoonsgegevens kunt u de website van de Autoriteit Persoonsgegevens raadplegen (<https://www.autoriteitpersoonsgegevens.nl/>). Voor specifieke vragen over uw rechten kunt u contact opnemen met Lean Kramer (Wageningen University & Research). De contactgegevens vindt u hieronder.

## **11. Vergoeding voor meedoen**

U maakt geen extra kosten voor het onderzoek. Aangezien het onderzoek nu volledig digitaal is, zijn er geen reiskosten.

## **12. Heeft u vragen?**

Bij vragen kunt u contact opnemen met één van de onderzoekers. Indien u klachten heeft over het onderzoek, kunt u dit ook bespreken met de onderzoekers.

Naam: Kimberly Rodenburg

E-mailadres: [kimberly.rodenburg@wur.nl](mailto:kimberly.rodenburg@wur.nl)

Telefoonnummer: 0637350978

Naam: Sifra Mulder

E-mailadres: [sifra.mulder@wur.nl](mailto:sifra.mulder@wur.nl)

Telefoonnummer: 0611894171

Heeft u klachten welke u niet met de onderzoeker wilt bespreken? Dan kunt u contact opnemen met:

Naam: Lean Kramer

E-mailadres: lean.kramer@wur.nl

### 13. Ondertekening toestemmingsformulier

Indien u toestemming geeft, vragen wij u het toestemmingsformulier op de volgende pagina in te vullen. Hiermee geeft u aan dat u de informatie heeft begrepen en instemt met deelname aan het onderzoek.

U ontvangt per e-mail een kopie van de informatiebrief en het toestemmingsformulier voor uw eigen administratie.

#### Toestemmingsformulier

Bent u gemotiveerd om deel te nemen aan de studie? Dan kunt u hier uw toestemming verlenen.

Met het geven van uw toestemming bevestigt u het volgende:

- Ik heb de informatiebrief gelezen. Ook kon ik vragen stellen. Mijn vragen zijn voldoende beantwoord. Ik had genoeg tijd om te beslissen of ik meedoe.
- Ik weet dat meedoen vrijwillig is. Ook weet ik dat ik op ieder moment kan beslissen om toch niet mee te doen of te stoppen met het onderzoek. Daarvoor hoef ik geen reden te geven.
- Ik geef toestemming voor het verzamelen en gebruiken van mijn gegevens voor de beantwoording van de onderzoeksvraag in dit onderzoek.
- Ik weet dat voor de controle van het onderzoek Lean Kramer toegang tot mijn gegevens kan krijgen. Ik geef toestemming voor die inzage door deze persoon.
- Ik wil meedoen aan dit onderzoek.

De onderzoekers, Kimberly Rodenburg en Sifra Mulder van Wageningen University & Research, verklaren het volgende: *“Ik verklaar dat ik deze proefpersoon volledig heb geïnformeerd over het genoemde onderzoek. Als er tijdens het onderzoek informatie bekend wordt die de toestemming van de proefpersoon zou kunnen beïnvloeden, dan breng ik hem/haar daarvan tijdig op de hoogte.”*

- Ja, ik wil deelnemen
- Nee, ik wil niet deelnemen

Indien u ons wilt laten weten waarom u niet wilt deelnemen, kunt u hieronder een reactie achterlaten. Dit is niet verplicht. Heeft u een vraag of wilt u een respons, vermeld dan uw e-mailadres zodat wij contact met u kunnen opnemen.

---

## Appendix B. Intake questionnaire

Graag zouden we wat meer informatie over u ontvangen. Zou u daarom onderstaande velden willen invullen?

1. Wat is uw geslacht?
  - Man
  - Vrouw
  - Anders, namelijk...
2. Wat is uw e-mailadres?
3. Wat is uw leeftijd?
4. Wat is uw hoogst afgeronde opleiding?
  - Geen
  - Basisonderwijs
  - Middelbaar onderwijs (MAVO, VMBO, HAVO, VWO)
  - Middelbaar beroepsonderwijs (MBO)
  - Hoger beroepsonderwijs (HBO)
  - Wetenschappelijk onderwijs (WO)
5. Op welk apparaat gaat u de PACO applicatie gebruiken?
  - iPad
  - Tablet (Samsung, Microsoft, HP, Acer, Asus of een ander merk dat niet Apple is)
  - Laptop of computer van Apple (MacBook of iMac)
  - Laptop of computer (Samsung, Microsoft, HP, Acer, Asus of een ander merk dat niet Apple is)
  - Anders, namelijk  
.....
6. Wat is uw motivatie om deel te nemen aan dit onderzoek?

Daarnaast zouden we u ook nog graag een paar vragen willen stellen over uw gezondheid. Zou u, tot slot, onderstaande vragen willen invullen?

7. Heeft u last van de volgende kwalen? (meerdere antwoorden mogelijk)
  - Hoge bloeddruk
  - Slijtage van heupen of knieën
  - Rugaandoening
  - Reuma
  - Incontinentie (urineverlies)
  - Diabetes
  - Nee, deze kwalen heb ik niet
8. Bent u in de afgelopen 3 maanden minder gaan eten?
  - Ik heb veel minder gegeten
  - Ik heb iets minder gegeten
  - Ik heb hetzelfde als altijd gegeten
9. Hoeveel gewicht heeft u in de afgelopen 3 maanden verloren?
  - Gewichtsverlies meer dan 3kg

- Zou niet weten hoeveel ik ben afgevallen
  - Gewichtsverlies tussen de 1 en 3 kg
  - Geen gewichtsverlies
10. Hoe zou u uw huidige mobiliteit omschrijven?
- Niet in staat om uit bed, uit een stoel of rolstoel te komen zonder hulp van iemand anders
  - In staat om uit bed of stoel te komen, maar ik kom het huis niet uit
  - In staat om zelfstandig mijn huis te verlaten
11. Heeft u in de afgelopen 3 maanden last gehad van stress of bent u ernstig ziek geweest?
- Ja
  - Nee
12. Bent u dementerend en/of voelt u zich sinds lange tijd ongelukkig?
- Ja, ernstig dementerend en/of langdurig ongelukkig
  - Ja, beetje dementerend, maar niet langdurig ongelukkig
  - Nee, ik ben niet dementerend en voel me niet ongelukkig

## Appendix C. User experience questionnaire

Beste deelnemer,

Welkom bij de PACO vragenlijst. Het is alweer vier weken geleden dat u de PACO applicatie in gebruik heeft genomen. In deze vragenlijst zijn wij benieuwd naar uw ervaring.

Het invullen duurt ongeveer 5 tot 10 minuten.

Mocht u vragen hebben kunt u altijd contact met ons opnemen via de contactgegevens in de mail.

Alvast hartelijk dank voor het invullen.

Vriendelijke groet,

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Sifra Mulder (sifra.mulder@wur.nl),  
Wageningen University & Research

Vul hier uw 4-cijferige code in:

---

Hieronder krijgt u stellingen die gaan over uw gebruikerservaring van PACO. Geef voor elke stelling het antwoord wat het best aan uw ervaring voldoet.

1. PACO was..

- Vervelend 1
- 2
- 3
- 
- 4
- Vermakelijk 5

2. PACO was..

- Suf 1
- 2
- 3
- 4
- Spannend

## 3. PACO was..

- Onprettig 1
- 2
- 3
- 4
- Prettig 5

## 4. PACO was..

- Saai 1
- 2
- 3
- 4
- Interessant 5

	Helemaal mee oneens	Mee oneens	Noch eens, noch oneens	Mee eens	Helemaal me eens
5. Ik denk dat PACO nuttig is voor mij	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Ik denk dat PACO geschikt is voor mij	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Ik denk dat PACO mij met veel dingen kan helpen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 8. PACO ziet er esthetisch uit.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

## 9. PACO ziet er prettig uit.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

10. PACO ziet er duidelijk uit.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

11. PACO ziet er schoon uit.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

12. PACO ziet er symmetrisch uit.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

13. Ik verstrek liever geen informatie over mijn persoonlijke voorkeuren.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

14. Ik maak me zorgen over anonieme informatie (informatie die automatisch wordt verzameld maar niet kan worden gebruikt om mij te identificeren, zoals mijn computer, netwerkinformatie, besturingssysteem, enz.) die over mij wordt verzameld.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

15. Ik maak me zorgen over hoe mijn persoonlijke niet-identificeerbare informatie (informatie die ik vrijwillig heb verstrekt maar die niet kan worden gebruikt om mij te identificeren, bijv. postcode, leeftijdscategorie, geslacht, etc.) zal worden gebruikt door PACO.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

16. Ik maak me zorgen over hoe mijn persoonlijk identificeerbare informatie (informatie die ik vrijwillig heb verstrekt EN kan worden gebruikt om mij te identificeren als een individu, bijv. naam, verzendadres, creditcard- of bankrekeninginformatie, sofinummer, enz.) zal worden gebruikt door PACO.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

17. Ik heb het gevoel veel controle te hebben over mijn gebruikservaring met PACO.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

18. Tijdens het gebruik van PACO kan ik zelf bepalen wat ik wil zien.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

19. Tijdens het gebruik van PACO had ik absoluut geen controle over wat ik kan doen.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

20. Ik kan zelf bepalen wat er gebeurt binnen PACO.

- Helemaal mee oneens 1
- 2
- 3
- 4
- 5
- 6
- Helemaal mee eens 7

Hieronder krijgt u stellingen die gaan over uw gebruikerservaring van PACO. Geef voor elke stelling het antwoord wat het best aan uw ervaring voldoet.

	Helemaal mee oneens 1	2	3	4	Helemaal mee eens 5
1. Ik zou PACO willen blijven gebruiken.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Ik vond PACO onnodig complex in elkaar zitten.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Ik vond PACO makkelijk te gebruiken.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Ik had hulp nodig om PACO goed te gebruiken.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Ik vond de verschillende onderdelen van PACO goed bij elkaar passen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Ik vond PACO inconsistent.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Ik denk dat de meeste mensen PACO snel onder de knie hebben.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Ik vond PACO erg lastig te gebruiken.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Ik gebruik PACO met veel zelfvertrouwen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Ik moest veel dingen leren voordat ik met PACO aan de slag kon.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## Appendix D. Interview schematic

### *Interview questions*

#### **Use / ECAs**

*Om te beginnen willen we u graag wat vragen stellen over het gebruik van de app en uw ervaring met de virtual coaches.*

1. Hoe heeft u het gebruik van de PACO app ervaren? Wat vond u fijn? En wat vond u minder fijn?  
→ Doorvragen naar gebruiksgemak, het format van de app, hoe de app eruitziet, de reacties, emoties en perspectieven van deelnemers hierover.
2. Is uw gebruik gedurende de studie veranderd?
  - a. Waarom wel/niet?
3. Wat is uw ervaring met de virtual agents in de app?
  - a. Is dit beeld nog veranderd gedurende de studie?
  - b. Waren deze indrukken anders voor Herman en Ellen?
  - c. Waren de virtual agents een toevoeging voor de app?

#### **Eetgedrag**

*Dan zouden we het nu graag willen hebben over het effect van de app op uw eetgedrag.*

4. Bent u anders gaan eten dan voordat u de applicatie heeft gebruikt?
  - a. Waarin merkt u dit?
  - b. Wat is er precies veranderd?  
→ Doorvragen naar welke producten groepen dit zijn: bv groente/fruit/drinken  
→ Doorvragen naar of dit gezonde of ongezonde producten zijn

#### **Eenzaamheid**

*Ook willen we u wat vragen stellen over de invloed van de app op uw sociale contacten en uw sociale omgeving.*

5. Is de omgang met uw sociale contacten veranderd door het gebruik van de app?
  - a. Waaraan merkt u dit?
  - b. Wat is er veranderd?

#### **Modules**

*We zouden nu graag de verschillende modules één voor één langs willen lopen en per module een paar vragen willen stellen over uw ervaring met deze modules. Ook zijn we benieuwd naar de effecten van de verschillende modules op uw eetgedrag en eenzaamheid gevoelens.*

#### Voedingsdagboek

6. Hoe heeft u het voedingsdagboek ervaren? Wat vond u fijn? En wat vond u minder fijn?
7. Wat voor effect heeft het voedingsdagboek gehad op uw eetgedrag? Kunt u dit toelichten?

*Indien niet eerder genoemd door interviewees:*

- a. Heeft het voedingsdagboek naar uw idee effect gehad op uw onafhankelijkheid in het veranderen van uw eetgedrag? Kunt u dit toelichten?
- b. Heeft het voedingsdagboek naar uw idee een effect gehad op uw bekwaamheid om eetgedrag te veranderen? (Met bekwaamheid wordt bedoeld in hoeverre u de vaardigheid en kennis hebt om iets te kunnen doen.) Kunt u dit toelichten?

### Doelenboek

8. Hoe heeft u het doelenboek ervaren? Wat vond u fijn? En wat vond u minder fijn?
9. Wat vond u van de vooraf opgestelde doelen?
10. Wat voor effect heeft het doelenboek gehad op uw eetgedrag? Kunt u dit toelichten?
11. Wat voor effect heeft het doelenboek gehad op uw sociale contacten/omgeving? Kunt u dit toelichten?

*Indien deze onderwerpen door de interviewees niet worden genoemd, doorvragen naar autonomie, competence en relatedness:*

- a. Heeft het doelenboek naar uw idee effect gehad op uw onafhankelijkheid in het veranderen van uw eetgedrag? Kunt u dit toelichten?
- b. Heeft het doelenboek naar uw idee een effect gehad op uw bekwaamheid om eetgedrag te veranderen? Kunt u dit toelichten?
- c. Heeft het doelenboek naar uw idee effect gehad op uw onafhankelijkheid in communiceren met uw sociale contacten? Kunt u dit toelichten?
- d. Heeft het doelenboek naar uw idee een effect gehad op het communiceren van u met uw sociale contacten? Kunt u dit toelichten?

### Receptenboek

12. Hoe heeft u het receptenboek ervaren? Wat vond u fijn? En wat vond u minder fijn?
13. Wat voor effect heeft het receptenboek gehad op uw eetgedrag? Kunt u dit toelichten?

### Verhalen

14. Hoe heeft u de verhalen ervaren?
  - a. Wat vond u fijn?
  - b. En wat vond u minder fijn?
15. Welke effecten hebben de verhalen op u gehad?
  - a. Kunt u dit toelichten?
    - Als dit er niet uit komt vragen welke verhalen de participant geluisterd heeft
    - en doorvragen welke van de beluisterde verhalen ook daadwerkelijk tot actie hebben geleid.

*Indien deze onderwerpen door de interviewees niet worden genoemd, doorvragen naar autonomie en relatedness:*

- b. Heeft de verhalen module naar uw idee effect gehad op uw onafhankelijkheid in communiceren met uw sociale contacten? Kunt u dit toelichten?
- c. Heeft de verhalen module naar uw idee een effect gehad op uw bekwaamheid om te communiceren met sociale contacten? Kunt u dit toelichten?

### Chat

16. Hoe heeft u de chat ervaren?

- a. Wat vond u fijn?
- b. En wat vond u minder fijn?

17. Welke effecten hebben de chat op u gehad?

- a. Kunt u dit toelichten?

*Indien nog niet genoemd door deelnemers zelf:*

- b. Heeft de chat u het gevoel gegeven dat u een deel uitmaakte van de deelnemersgroep?
  - i. Kunt u dit toelichten?
- c. Heeft de chat ervoor gezorgd dat u nieuwe sociale contacten heeft opgedaan?
  - i. Kunt u dit toelichten?

### **Omstandigheden**

*Tot slot zouden we graag willen weten wat uw vindt van het gebruik van deze app in corona tijd.*

18. Denkt u dat u de app op een andere manier zou gebruiken als er geen corona omstandigheden zouden zijn? Waarom wel/niet?

**Appendix E. Coding Scheme**

<b>Main</b>	<b>Secondary</b>
Use	Getting used to it
	Easy/simple
Relationship with ECA	Unawareness of coaches
	No addition
	Addition
Loneliness	Emotional loneliness
	Social loneliness
BCT	Action planning (doelenboek)
	Social learning (verhalenmodule)
	Social facilitation (chat)
SDT	Autonomy
	Relatedness
Corona	
Other	